

AMENDMENTS TO THE CLAIMS

Claims 1-36 (Canceled)

37. (New) A component mounting order optimization method executed before carrying out a component mounting operation in which a component is held from one component supply part disposed at a component holding position among a plurality of component supply parts arranged in parallel and arranged movably for supplying components, is transferred to a component mounting position, and is mounted to a mounting point on a circuit board disposed at the component mounting position by moving in X-axis and Y-axis directions, the method comprising:

representing the mounting point in a three dimensional space which is given that a Z-number showing a location of each component supply part is expressed by a Z-axis and a plane of the circuit board is expressed by the X and Y-axes; and

determining an arrangement of the component supply parts and a component mounting order on the circuit board so that a component mounting path connecting the mounting points in the three dimensional space becomes the shortest.

38. (New) The component mounting order optimization method according to Claim 37, wherein the determining operation has:

optimizing the arrangement of the component supply parts with position information of the mounting points taken into account; and then

optimizing the component mounting path in the three dimensional space so that the mounting path becomes the shortest under the optimized arrangement of the component supply parts.

39. (New) The component mounting order optimization method according to Claim 38, further comprising:

after the optimization of the component mounting path, rearranging the component supply parts; optimizing the component mounting path again under the rearrangement of the component

supply parts; and selecting a component mounting path having a shorter mounting path length through comparison between before and after the rearrangement of the component supply parts.

40. (New) The component mounting order optimization method according to Claim 38, wherein the optimization of the arrangement of the component supply parts is carried out by temporarily arranging the component supply parts and correcting the temporary arrangement before optimizing the component mounting path.

41. (New) The component mounting order optimization method according to Claim 40, wherein the temporary arrangement in optimizing the arrangement of the component supply parts is executed by obtaining a product of variances for each of X and Y coordinate values and Z-values showing locations of the component supply parts in terms of the mounting points of the circuit board while the Z-value is changed, and then obtaining the arrangement of the component supply parts which makes the variance product smaller.

42. (New) The component mounting order optimization method according to Claim 41, wherein, the arrangement which makes the variance product smaller is obtained by executing:

 a first process of obtaining a first variance product for a first arrangement of the component supply parts;

 a second process of obtaining a second variance product for a second arrangement different from the first arrangement; and

 a third process of comparing the first variance product and the second variance product with each other and setting the smaller one as a new first variance product, thereby obtaining a much smaller new first variance product by repeating the second process and the third process subsequently.

43. (New) The component mounting order optimization method according to Claim 40, wherein, for correcting the temporary arrangement in optimizing the arrangement of the component supply

parts, after the component supply parts are temporarily arranged by obtaining the smaller variance product, the location of a second component supply part is changed on a basis of a distance between a reference mounting position on the circuit board where the component supplied from a first component supply part adjacent to the component holding position is to be mounted and an object mounting position on the circuit board where the component supplied from the second component supply part other than the first component supply part is to be mounted, thereby further optimizing the arrangement of the component supply parts.

44. (New) The component mounting order optimization method according to Claim 43, wherein the changing of the location of the second component supply part comprises:

obtaining each of the distances while the second component supply part is sequentially changed; and

arranging the second component supply part which makes the distance shortest adjacent to the first component supply part.

45. (New) The component mounting order optimization method according to Claim 38, wherein the component mounting path is optimized by selecting two mounting paths for connecting two mounting points among mounting paths, recombining the two mounting paths, and selecting the path having a shorter mounting path length through comparison between before and after the recombination, thereby executing the optimization.

46. (New) A component mounting order optimization program for making a computer execute a component mounting order optimization method in a component mounting operation in which a component is held from one component supply part disposed at a component holding position among a plurality of component supply parts arranged in parallel and movable for supplying components, is transferred to a component mounting position, and is mounted to a mounting point on a circuit board disposed at the component mounting position by moving in X-axis and Y-axis directions, the program comprising:

a procedure of representing the mounting point in a three dimensional space which is given that a Z-number showing a location of each component supply part is expressed by a Z-axis and a plane of the circuit board is expressed by the X and Y-axes; and

a procedure of determining an arrangement of the component supply parts and a component mounting order on the circuit board so that a component mounting path connecting the mounting points in the three dimensional space becomes the shortest.

47. (New) The component mounting order optimization program according to Claim 46, wherein the procedure of determination has:

a procedure of optimizing the arrangement of the component supply parts with position information of the mounting points taken into account; and then

a procedure of optimizing the component mounting path in the three dimensional space so that the mounting path becomes the shortest under the optimized arrangement of the component supply parts.

48. (New) The component mounting order optimization program according to Claim 47, further comprising:

after the optimization of the component mounting path, a procedure of rearranging the component supply parts; a procedure of optimizing the component mounting path again under the rearrangement of the component supply parts; and a procedure of selecting a component mounting path having a shorter mounting path length through comparison between before and after the rearrangement of the component supply parts.

49. (New) The component mounting order optimization program according to Claim 47, wherein the optimizing procedure for the arrangement of the component supply parts includes a procedure of temporarily arranging the component supply parts and a procedure of correcting the temporary arrangement before the optimizing procedure for the component mounting path.

50. (New) The component mounting order optimization program according to Claim 49, wherein the temporary arrangement procedure in the optimizing procedure for the arrangement of the component supply parts includes a procedure of obtaining a product of variances of each of X and Y-coordinate values and Z-values showing locations of the component supply parts while the Z-value is changed in terms of the mounting points of the circuit board, and a procedure of obtaining the arrangement of the component supply parts which makes the variance product smaller.

51. (New) The component mounting order optimization program according to Claim 50, wherein the arrangement procedure of making the variance product smaller includes:

a first procedure of obtaining a first variance product for a first arrangement of the component supply parts;

a second procedure of obtaining a second variance product for a second arrangement different from the first arrangement;

a third procedure of comparing the first variance product and the second variance product with each other and setting the smaller one as a new first variance product; and

a procedure of obtaining a much smaller new first variance product by repeating the second procedure and the third procedure subsequently.

52. (New) The component mounting order optimization program according to Claim 49, wherein the correcting procedure for the temporary arrangement in optimizing the arrangement of the component supply parts includes, after the component supply parts are temporarily arranged by obtaining the smaller variance product, a procedure of changing the location of a second component supply part on a basis of a distance between a reference mounting position on the circuit board where the component supplied from a first component supply part adjacent to the component holding position is to be mounted and an object mounting position on the circuit board where the component supplied from the second component supply part other than the first component supply part is to be mounted, thereby further optimizing the arrangement of the component supply parts.

53. (New) The component mounting order optimization program according to Claim 52, wherein the procedure of changing the location of the second component supply part includes a procedure of obtaining each of the distances while the second component supply part is sequentially changed and arranging the second component supply part which makes the distance shortest to be adjacent to the first component supply part.

54. (New) The component mounting order optimization program according to Claim 47, wherein the optimizing procedure for the component mounting path includes a procedure of selecting two among mounting paths for connecting two mounting points, recombining the two mounting paths, and selecting the path having a shorter mounting path length through comparison between before and after the recombination, thereby executing the optimization.

55. (New) A computer readable recording medium with a program stored for making a computer execute a component mounting order optimization method in a component mounting operation in which a component is held from one component supply part disposed at a component holding position among a plurality of component supply parts arranged in parallel and movable for supplying components, is transferred to a component mounting position, and is mounted to a mounting point on a circuit board disposed at the component mounting position by moving in X-axis and Y-axis directions,

the recording medium having the program for executing:

a procedure of representing the mounting point in a three dimensional space which is given that a Z-number showing a location of each component supply part is expressed by a Z-axis and a plane of the circuit board is expressed by the X and Y-axes; and

a procedure of determining an arrangement of the component supply parts and a component mounting order on the circuit board so that a component mounting path connecting the mounting points in the three dimensional space becomes the shortest.

56. (New) The computer readable recording medium according to Claim 55, wherein the procedure of determination has:

a procedure of optimizing the arrangement of the component supply parts with position information of the mounting points taken into account; and then

a procedure of optimizing the component mounting path in the three dimensional space so that the mounting path becomes the shortest under the optimized arrangement of the component supply parts.

57. (New) The computer readable recording medium according to Claim 56, further comprising:

after the optimization of the component mounting path, a procedure of rearranging the component supply parts;

a procedure of optimizing the component mounting path again under the rearrangement of the component supply parts; and a procedure of selecting a component mounting path having a shorter mounting path length through comparison between before and after the rearrangement of the component supply parts.

58. (New) The recording medium according to Claim 56, wherein the optimizing procedure for the arrangement of the component supply parts includes a procedure of temporarily arranging the component supply parts and a procedure of correcting the temporary arrangement before the optimizing procedure for the component mounting path.

59. (New) The recording medium according to Claim 58, wherein the temporary arrangement procedure in the optimizing procedure for the arrangement of the component supply parts includes a procedure of obtaining a product of variances of each of X and Y-coordinate values and Z-values showing locations of the component supply parts while the Z-value is changed in terms of the mounting points of the circuit board, and a procedure of obtaining the arrangement of the component supply parts which makes the variance product smaller.

60. (New) The recording medium according to Claim 59, wherein the arrangement procedure for making the variance product smaller includes:

a first procedure of obtaining a first variance product for a first arrangement of the component supply parts;

a second procedure of obtaining a second variance product for a second arrangement different from the first arrangement;

a third procedure of comparing the first variance product and the second variance product with each other and setting the smaller one as a new first variance product; and a procedure of obtaining a much smaller new first variance product by repeating the second procedure and the third procedure subsequently.

61. (New) The recording medium according to Claim 58, wherein the correcting procedure for the temporary arrangement in optimizing the arrangement of the component supply parts includes, after the component supply parts are temporarily arranged by obtaining the smaller variance product, a procedure of changing the location of a second component supply part on a basis of a distance between a reference mounting position on the circuit board where the component supplied from a first component supply part adjacent to the component holding position is to be mounted and an object mounting position on the circuit board where the component supplied from the second component supply part other than the first component supply part is to be mounted, thereby further optimizing the arrangement of the component supply parts.

62. (New) The recording medium according to Claim 61, wherein the procedure of changing the location of the second component supply part includes a procedure of obtaining each of the distances while the second component supply part is sequentially changed, and arranging the second component supply part which makes the distance shortest to be adjacent to the first component supply part.

63. (New) The recording medium according to Claim 56, wherein the optimizing procedure for the component mounting path includes a procedure of selecting two among mounting paths for connecting two mounting points, recombining the two mounting paths, and selecting the path having a shorter mounting path length through comparison between before and after the recombination, thereby executing the optimization.

64. (New) A component mounting apparatus comprising:

- a component supply unit having a plurality of supply parts arranged in parallel for supplying components, for supplying components from one of the supply parts positioned to a component holding position;
- a component shift device having a component holder, for transferring the component holder between the component holding position and a component mounting position, holding components supplied from the supply parts by the component holders and mounting the components to mounting points on a circuit board at the component mounting position;
- an orthogonal table for holding the circuit board and moving the circuit board in X and Y-axes directions, thereby locating the mounting points to the component mounting position; and
- a controller for optimizing a mounting operation of the components to the circuit board from the supply parts, which includes an arrangement optimizing part for representing the mounting point in a three dimensional space which is given that a Z-number showing a location of each component supply part is expressed by a Z-axis and a plane of the circuit board is expressed by the X and Y-axes, and a mounting path optimizing part for determining an arrangement of the component supply parts and a component mounting order on the circuit board so that a component mounting path connecting the mounting points in the three dimensional space becomes the shortest.

65. (New) The component mounting apparatus according to Claim 64, wherein the arrangement optimizing part carries out optimization of the arrangement of the component supply parts with position information of the mounting points taken into account, and the mounting path optimizing part carries out optimization of the component mounting path in the three dimensional space so that

the mounting path becomes the shortest under the optimized arrangement of the component supply parts.

66. (New) The component mounting apparatus according to Claim 65, wherein the mounting path optimizing part further carries out rearrangement of the component supply parts after the optimization of the component mounting path, optimization of the component mounting path again under the rearrangement of the component supply parts, and selection of a component mounting path having a shorter mounting path length through comparison between before and after the rearrangement of the component supply parts.

67. (New) The component mounting apparatus according to Claim 64, wherein the arrangement optimizing part obtains a product of three variances of each of X and Y-coordinate values and Z-values showing locations of the supply parts while the Z-value is changed in terms of the mounting points on the circuit board, and obtains the arrangement of the component supply parts which makes the variance product smaller.

68. (New) The component mounting apparatus according to Claim 67, wherein the arrangement optimizing part obtains the arrangement which makes the variance product smaller by obtaining a first variance product for a first arrangement of the supply parts, obtaining a second variance product for a second arrangement different from the first arrangement, comparing the first variance product and the second variance product with each other to set the smaller one as a new first variance product, and obtaining a much smaller variance product as a new first variance product by repeating the comparison.

69. (New) The component mounting apparatus according to Claim 67, wherein the arrangement optimizing part further optimizes the arrangement of the supply parts, after optimizing the arrangement of the supply parts by obtaining the smaller variance product, caused by changing a location of a second supply part on a basis of a distance between a reference mounting position

where the component supplied from a first supply part adjacent to the component holding position is to be mounted and an object mounting position where the component supplied from the second supply part other than the first supply part is to be mounted.

70. (New) The component mounting apparatus according to Claim 69, wherein for changing the location of the second supply part, the distance is obtained while the second supply part is sequentially changed and the second supply part which makes the distance shortest is arranged adjacent to the first supply part.

71. (New) The component mounting apparatus according to Claim 64, wherein the mounting path optimizing part optimizes by selecting two among mounting paths for connecting two mounting points, recombining the two mounting paths, and selecting the path having a shorter mounting path length through comparison between before and after the recombination.

72. (New) The component mounting apparatus according to Claim 71, wherein the mounting path optimizing part changes a mounting order of mounting points which constitute a new mounting path after the recombination of mounting paths, in accordance with the new mounting path.